SPRAGUE

TEL-OHMIKE HAND BOOK

Model TO-3 Serial No. 1015362

SPRAGUE PRODUCTS CO.
NORTH ADAMS, MASSACHUSETTS

CONDENSER & RESISTOR REPLACEMENT

CONDENSERS

The varied applications and types of condensers used in radio sets and other electronic equipment present a difficult problem to the service engineer. He seldom has sufficient data pertaining to their normal characteristics, and heretofore he has not been able to determine the extent of the changes in these characteristics which make replacement necessary. The Sprague Model TO-3 alcng with this Operating Manual supplies this need.

It is seldom sufficient to know only the capacity value of a condenser since the proper operation of the equipment in which it is used depends as much on other factors, such as leakage current and power factor, as it does on the capacity. In order to know whether or not a condenser is satisfactory it is necessary to measure all of its characteristics under operating conditions as outlined below.

The exact tolerances which are permissible are governed by the particular application. Broad variations may be found between condensers of various makes, and between condensers in the same circuit positions in radio equipment made by different manufacturers. The information given on the following pages is of necessity general in character, and gives tolerances which are in accordance with good practice. The service notes covering the equipment being tested should be consulted for specific data.

RESISTORS

The fixed resistors used in radio sets and allied equipment fall into two general classes - the carbon or composition type generally rated at three watts or less, and the wire wound type generally rated at five watts or more.

The usual tolerance for the carbon type is ±20%, while that for the wire wound type is ±10%. See the color code on Page 10 for the tolerance code of carbon resistors.

Volume controls and other variable resistors may also be divided into the same two classes - carbon and wire wound. In general variable resistors of 50,000 ohms and above are of the carbon type, however those below this value are not necessarily wire wound. The tolerances are generally the same as for the fixed resistors of the same type.

OPERATING INSTRUCTIONS

I. GENERAL

A. - Insert the line plug into a 115 V-60 Cycle receptacle and slide the OFF-ON switch to the ON position.

B. - IMPORTANT. In order to prevent damage to your TEL-OHMIKE ALWAYS test electrolytic condensers for leakage BEFORE measuring the capacity. Condensers whose leakage current exceeds the values listed on Page 5 should be replaced without making further tests.

II. RESISTORS

A. - Set the SELECTOR to the R_1, R_2, or R_3 position depending upon the value of the resistance to be measured.

B. - Insert the resistor to be measured in the binding posts.

C. - Rotate the calibrated control slowly until the position is reached at which the maximum "eye" opening is obtained. Read the resistance directly in ohms or megohms.

D. - If the "eye" "flickers" or "winks" the resistor being tested has intermittent internal connections and should be replaced.

E. - If the color code of the resistor being measured indicates a high value such as 1 megohm while the measured value is small such as 10 ohms, the resistor is shorted and should be replaced. If a 1 megohm resistor tests above 25 megohms, it is open and should be replaced. See Page 10 for the color code.

III. PAPER, MICA AND OIL CONDENSERS

A. - INSULATION RESISTANCE: The insulation resistance of these condensers is ordinarily independent of their DC voltage rating, consequently the TO-3 can be satisfactorily used to test the high voltage condensers used in transmitters, television receivers, etc.

1. Set the VOLTAGE control to the OFF position.

2. Set both the SELECTOR and METER RANGE switches to the INS. RES. position.

3. Insert the condenser to be tested in the binding posts. Advance the VOLTAGE control in small steps allowing the eye to come to rest at each step. Advance the control until the wings of the eye are 1/64" apart (1° shadow angle). Note that as the control is advanced, the eye opens then closes. This is due to the charging current which results from the increase in voltage as the control is advanced. Sufficient time must be allowed at each step to permit the condenser to fully charge (no change in eye opening) or false results will be obtained. Read the insulation resistance directly on the meter. If the eye remains open for all positions of the control, the insulation resistance is greater than 2,500 megohms. If the eye flutters with the VOLTAGE control at any given position (after sufficient time has been allowed), the condenser is defective and should be replaced.

LEAKAGE RESISTANCE	NORMAL	REPLACE
Filter and By-Pass Condensers	500 Megohms per MFD above .1 MFD. 2,500 Megohms total resistance per condenser for condensers less than .1 MFD.	100 Megohms per MFD. above .1 MFD. 1,000 Megohms total resistance per condenser for units less than .1 MFD.
Divide total leakage resistance in Megohms by capacity in MFD. If the value is less than 100 Megohms/MFD the condenser should be replaced.		
Coupling Condensers	500 Megohms per MFD above .1 MFD. 2,500 Megohms total resistance per condenser for condensers less than .1 MFD.	When leakage resistance falls to 20 times the value of the grid resistance.

B. - CAPACITY AND POWER FACTOR:

1. Place the PAPER-MICA ELECTROLYTIC switch in the PAPER-MICA position and set the POWER FACTOR control at 0.

2. If the condenser to be measured is below .001 MFD attach the leads directly to the binding posts without using test leads. The use of long test leads, which have some capacity, may give incorrect readings when very low capacities are measured.

3. Place the SELECTOR in the C_1, C_2, or C_3 position depending upon the capacity to be measured. No polarizing voltage is needed for this test.

4. Rotate the center control for maximum "eye" opening and read the capacity directly from the scale used. If the C_3 range is being used, power factor may also be measured. In this case, adjust the POWER FACTOR control for maximum opening of the "eye". While the permissible power factor depends upon the application, in general if a reading is obtained above 2% the condenser should be replaced.

5. If the reading for a paper condenser is obtained at a low capacity part of the scale, the condenser is open. If the reading is obtained at the high capacity part of the scale, a short is indicated. For example: if a condenser is marked .1 MFD and the TEL-OHMIKE shows a reading of less than .001 MFD the condenser is open, while a reading of over .5 MFD would indicate that the condenser is shorted.

CAPACITY TOLERANCE	Up to .002 MFD		Over .002 MFD	
	NORMAL	REPLACE	NORMAL	REPLACE
Filter and By-Pass Condensers	-25% +50%	-33% +100%	-10% + 40%	- 20% +100%
Coupling Condensers	-20% +20%	-30% +30%	-20% +20%	-30% +30%

IV. DRY ELECTROLYTIC CONDENSERS

A. - LEAKAGE CURRENT:

1. All measurements should be made at room temperature (75° F.). Leakage current should be read after rated working voltage has been maintained on the condenser for a five minute period. The time required for the leakage current to fall to its normal value is as important as the value of the leakage current itself. Condensers which require more than five minutes to reach normal leakage should be replaced.

2. Set the SELECTOR to the LEAKAGE position, and the VOLTAGE knob to the OFF position.

3. Set the METER RANGE switch to a voltmeter range near that of the DC voltage rating of the condenser to be tested. (For a 450 volt condenser use the 750 volt range).

4. Insert the condenser to be tested in the binding posts observing polarity.

5. Adjust the polarizing voltage by rotating the VOLTAGE knob until the voltmeter reading equals the DC voltage rating of the condenser.

6. Turn the METER RANGE switch to the first current position (75 MA) and observe the meter reading. If the reading is less than 15 MA, turn the METER RANGE switch to the next position. See the tables for the permissible values of leakage current. Condensers which have a leakage current greater than normal should be replaced and no further tests

should be made. Electrolytic condensers which show no leakage current at normal polarizing voltage are open and should be replaced. If the leakage current is normal the condenser should be tested for Capacity and Power Factor.

	NORMAL	REPLACE
Filter Condensers	.5 M.A.+.05 M.A./MFD.	1 M.A.+.06 M.A./MFD
By-Pass Condensers	.1 M.A.+.01 M.A./MFD.	.2 M.A.+.015 M.A./MFD.

B. - CAPACITY AND POWER FACTOR

1. Turn the METER RANGE switch to the OFF position. Always have this switch in the OFF position except when measuring current, voltage or insulation resistance.

2. Set the SELECTOR to the C_3 or C_4 position depending upon the capacity to be measured. (C_3 for capacities up to 50 MFD, and C_4 for capacities between 50 and 2,000 MFD).

3. Slide the PAPER-MICA-ELECTROLYTIC switch to the ELECTROLYTIC position. Place the METER RANGE switch on the correct range and advance the VOLTAGE control until the meter reads the DC voltage rating of the condenser under test.

4. Rotate the center control until maximum opening of the "eye" is observed. Adjust the POWER FACTOR control for maximum "eye" opening, readjusting the center control slightly, if necessary. Read the capacity and power factor directly. If the capacity reading is obtained near the high end of the scale, the best reading accuracy will be obtained if the next higher range is used. If the "eye" winks or flutters after the reading is obtained, there is an intermittent "open" or "short" either in the condenser being tested or in the connections to the condenser. See the table for the tolerances on Dry Electrolytic Condensers. Condensers which are out of tolerance on any characteristic should be replaced.

CAPACITY TOLERANCE	NORMAL	REPLACE
	−10% +60%	− 20% +120%
POWER FACTOR	NORMAL	REPLACE
Filter Condensers	15%	25%
By-Pass Condensers	25%	40%

V. WET ELECTROLYTIC CONDENSERS

There are two types of wet electrolytic condensers in use in radio receivers; the "standard" wet and the "regulating" wet condensers. The "standard" type is the conventional wet condenser, while the "regulating" type is a special condenser designed to regulate the voltage output from the rectifier system while the tubes in the set warm up.

Regulating wet condensers are sometimes marked with an "R", but many are in service without this marking. Practically all 300 and 350 rated working voltage wets in service are of the regulating type. Wets of these voltage ratings should be replaced with special dry electrolytics such as Sprague type RW.

Before replacing a regulating wet condenser the DC voltage across it should be measured, after the receiver has thoroughly warmed up, to be certain that the voltage rating of the condenser is not exceeded. Practically all failures of regulating wets are caused by excessive DC voltage under high line voltage conditions. If the DC voltage exceeds the rating of the "regulating" condenser it is best to replace it with a Sprague type RW, and to replace the other filter and by-pass condensers in the set with units of proper voltage rating.

In some radio receivers wet condensers of 300 and 350 volts rating will be found connected in series with a high resistance of the order of 10,000 to 30,000 ohms. These are not "regulating" wets, and should be replaced with Sprague type RW of proper capacity rating.

The time required for the leakage current to fall to the normal value is as important as the value of the current itself. When the rated working voltage is applied to a wet condenser the leakage current should fall to normal value in a period not exceeding 5 minutes for the standard wets and 10 minutes for the regulating type of wet condenser. Condensers which draw more than the above values or current at the end of the times given should be replaced. Any wet condenser which makes a "hissing" or "sparkling" sound at any voltage up to rated voltage plus 10 volts is defective and should be replaced.

	NORMAL	REPLACE
LEAKAGE CURRENT	1 M. A.+ .1 M.A. per MFD. Maximum value 2.5 M.A.	Leakage current over 2.5 M.A.

	NORMAL	REPLACE
CAPACITY TOLERANCE	— 10% + 50%	— 20% + 100%

These tolerances apply to both "standard" and "regulating" types of wet condensers.

POWER FACTOR:

The permissible power factor of wet electrolytic condensers varies with the rated capacity and working voltage. The following table gives the normal and replacement values for "standard" wet electrolytic condensers. The permissible values for "regulating" wets are twice the values given in the table. The operating procedure in checking wet electrolytic condensers is exactly the same as that used in checking dry electrolytics.

POWER FACTOR OF WET ELECTROLYTIC CONDENSERS IN % AT 60 CYCLES										
MEASURED CAPACITY IN MICROFARADS	RATED D.C. WORKING VOLTAGE									
	0 to 350 VOLTS		350 to 400 VOLTS		450 to 475 VOLTS		500 VOLTS		525 VOLTS	
	NORMAL	REPLACE	NORMAL	REPLACE	NORMAL	REPLACE	NORMAL	REPLACE	NORMAL	REPLACE
4	9%	25%	10%	25%	12%	25%	13%	25%	13.5%	25%
6	11	25	13.5	25	17	26	18	27	19	29
8	12	25	15	25	20	30	22	33	23	35
10	15	25	18.5	28	24	36	26	39	27	41
12	18	27	22	33	28	42	30	45	32	48
14	18.5	27.5	22	33	28	42	30	45	32.5	49
16	20	30	24	36	29	43	32	48	34	51
18	20	30	24	36	32	48	35	53	38	57
20	22	33	26	39	32	48	36	54	38.5	58
25	23	34.5	28	42	34	51	36	54	39	59
30	27	40	32	48	37	51	41	61	45	68
35	27	40	33	49	37	56	42	63		
40	29	43.5	35	53	37	56	42	63		

VI. MOTOR STARTING CONDENSERS

The procedure used in checking motor starting condensers is the same as that used on other electrolytic condensers EXCEPT that no polarizing voltage should be used.

CAPACITY TOLERANCE	NORMAL − 5% + 10%	REPLACE − 10% + 25%
POWER FACTOR	NORMAL 10%	REPLACE 15%

VII. DC VOLT-MILLIAMMETER
(Voltmeter Resistance 1,000 ohms per volt)

A. - Set the SELECTOR switch to DC METER.

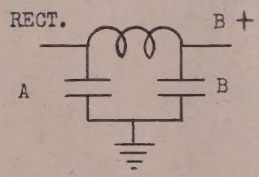
B. - Set the METER RANGE switch to the range near that of the voltage or current to be measured. (If B supply of 400 volts is to be measured use the 750 V. range).

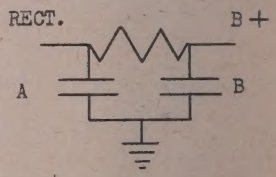
C. - Insert test leads in the binding posts observing polarity.

VIII. SPEEDY CHECK

The Sprague Tel-Ohmike may be used to Speedy Check electrolytic, paper, and mica condensers for "shorts", "opens", or intermittent defects without removing them from the circuit in which they are used. The radio set or other equipment under test MUST be removed from the power line however.

Typical filter circuits are shown below. Connect test leads from the Tel-Ohmike to the condenser to be tested (begin with condenser A) observing polarity if electrolytics are being tested.





Turn the Selector to the C_1, C_2, C_3, or C_4 position depending upon the capacity to be measured. Rotate the center control until the maximum opening of the eye is obtained. Adjust the Power Factor control for maximum eye opening (if C_3 or C_4 ranges are in use). It is not necessary to use polarizing voltage during the Speedy Check.

If maximum opening of the eye is obtained at the high end of C_4 (assume that a 12 MFD condenser is being tested), either the condenser or rectifier (tube or dry disc) is shorted. In this case, remove the lead of condenser A from the circuit and test it in the regular way. If condenser A is marked 12 MFD and measures .1 it is open and should be replaced without further testing. If the eye "winks", condenser A or some other component in the circuit is intermittent. Condenser A should then be disconnected from the circuit and tested in the normal way. Thus the defect can be quickly isolated.

If the Speedy Check shows condenser A to be satisfactory (neither open, shorted or intermittent), condenser B should be Speedy Checked.

When making the Speedy Check do not reject a condenser because the capacity or power factor readings are out of tolerance (according to the tables).

While the above detailed instructions have covered filter circuits, any other paper, mica or electrolytic condensers can be Speedy Checked provided that the resistance shunted across it is high compared with the reactance of the condenser at 60 cycles.

Screen by-pass condensers, coupling condensers and isolating condensers are among those which may be Speedy Checked to good advantage.

GUARANTEE

The Sprague Tel-Ohmike is fully guaranteed against defects in material and workmanship for a period of ninety (90) days from the date of receipt by the owner. Our guarantee is limited to the repair or replacement of defective material or workmanship, provided the instrument is returned to us in accordance with the terms noted below.

1. THIS GUARANTEE IS NOT VALID UNLESS THE ATTACHED REGISTRATION CARD IS PROPERLY FILLED IN AND RETURNED TO SPRAGUE PRODUCTS COMPANY, NORTH ADAMS, MASS., WITHIN FIVE (5) DAYS AFTER RECEIPT BY THE OWNER.

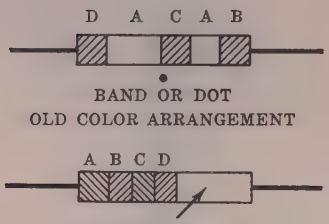
2. THIS GUARANTEE IS VOID IF THE SEAL ON THE REAR OF THE INSTRUMENT HAS BEEN REMOVED OR TAMPERED WITH.

3. DAMAGE DUE TO ABUSE OR MISUSE IS NOT COVERED BY THIS GUARANTEE.

If the return of this instrument is deemed necessary, advise SPRAGUE PRODUCTS COMPANY, NORTH ADAMS, MASS., giving full details. Our reply and instructions will reach you within five (5) days after receipt of your letter. NO ADJUSTMENTS WILL BE MADE UNLESS OUR CONSENT FOR THE RETURN OF THE INSTRUMENT IS OBTAINED BEFORE MAKING SHIPMENT.

NOTE: RETURNED INSTRUMENTS MUST BE PACKED CAREFULLY, MARKED FRAGILE, AND SHIPPED BY PREPAID EXPRESS.

RMA COLOR CODES FOR RESISTORS (OHMS)



Body color (new color arrangement only) indicates type of resistor, as follows:

Black—Composition, non-insulated.

Tan, Olive or White—Composition, insulated.

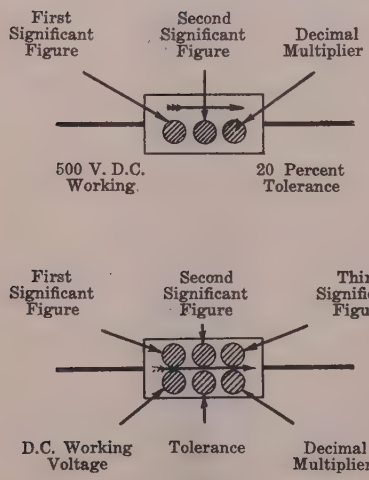
Dark Brown—Wire-wound, insulated.

COLOR	A 1st Digit	B 2nd Digit	C Multiplier
Silver			0.01
Gold			0.1
Black		0	1.0
Brown	1	1	10
Red	2	2	100
Orange	3	3	1,000
Yellow	4	4	10,000
Green	5	5	100,000
Blue	6	6	1,000,000
Purple	7	7	10,000,000
Gray	8	8	100,000,000
White	9	9	

D—Tolerance Code:

Gold—5% Silver—10% No Color—20%

RMA COLOR CODES FOR CAPACITORS (MMF)



Color	Numeral	Volts	Multiplier	Total
Black	0		1	
Brown	1	100	10	1%
Red	2	200	100	2%
Orange	3	300	1,000	3%
Yellow	4	400	10,000	4%
Green	5	500	100,000	5%
Blue	6	600	1,000,000	6%
Violet	7	700	10,000,000	7%
Grey	8	800	100,000,000	8%
White	9	900	1,000,000,000	9%
Gold		1,000	0.1	5%
Silver		2,000	0.01	10%
No Color		500		20%

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